source

DECEMBER 1992

Water and Sanitation: Environmental Priorities

When the dust finally settled after the Earth Summit in Rio de Janeiro in June, one message came through loud and clear: water and sanitation are priority environmental issues for the one billion people in developing countries who do not have access to safe water and the 1.7 billion without proper sanitary waste disposal.

Time and again, reporting on the conference echoed this theme. "Ecology means a home to live in, water to drink and basic sanitation," Pedro Mendonca told a *Washington Post* correspondent. Mr. Mendonca is an activist with the Federation of Favela Dwellers of the State of Rio de Janeiro, a group that assists poor residents in some of South America's largest and most squalid slums.

Newsweek noted that more than three million children died last year from water-borne diseases. "Most of these deaths could have been prevented by safe water and decent sanitation — public works that go unfunded," it stated.

And in an open letter, which appeared in the *International Herald Tribune*, four prominent lawmakers from developed countries urged the World Bank to "ensure that some of the resources being spent on water and safe sanitation are shifted away from large-scale projects to projects that utilize new, relatively inexpensive technologies that can effectively reach the poorest people."

Thousands of men and women in poor urban and rural communities throughout the developing world had taken this message to heart long before the Earth Summit inspired such public commentary. For several years, they have been working to improve their environmental living conditions by securing water and sanitation for their homes and neighbourhoods.

This issue of *Source* is dedicated to their efforts. Ruth Massey writes about how rural Mexican women learned to manufacture handpumps and now earn a good living for themselves while ensuring clean water for dozens of families. Robert Pini relates how poor communities in Bolivia and Honduras have pooled meagre resources to purchase low-cost water and sanitation technologies. I. Rajeswary writes about Yemeni farmers adopting appropriate irrigation technologies to reduce wastage and help optimize water use. Mary Lynn Hanley reports on how a Palestinian refugee community created a healthier environment by replacing open drainage ditches with closed sewers. Arif Hasan shares his experience of working with a squatter settlement in Karachi which built an innovative low-cost sewage system that serves more than 600,000 people.

We hope you find these stories of progress inspiring for your own water and sanitation programmes.

—The Editors

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Page 12: An extension worker in Bolivia teaching health education.

Page 17: Irrigation technology helps Yemeni farmers conserve water.

Cover: Esther Ruiz manufactures handpumps in Mexico. Photo: Ruth Massey / UNDP.

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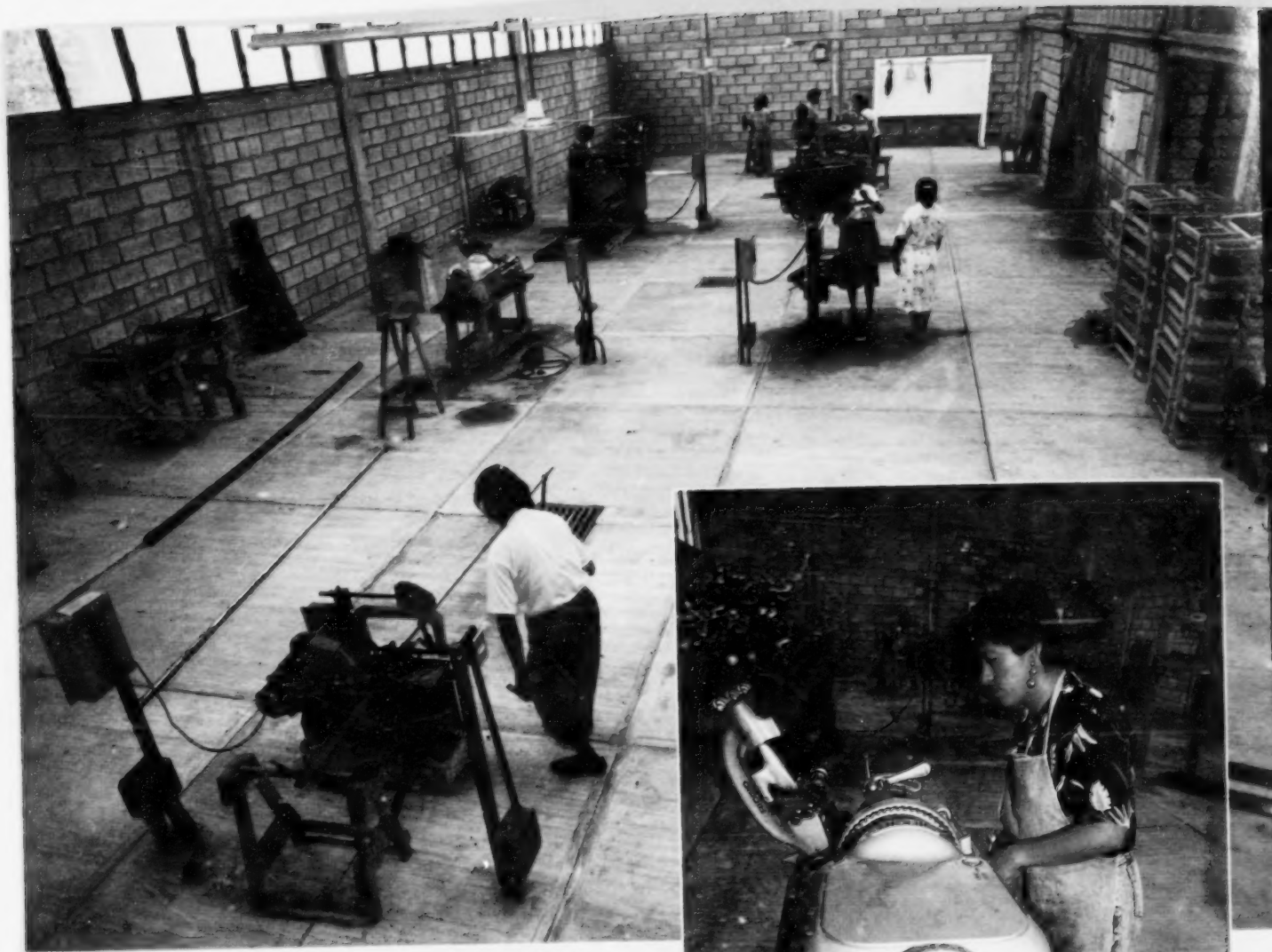

Mercedes Garcia uses a lathe at the Tempoal Handpump Factory.

Mexican Women Make Pumps and Mold Their Futures

By Ruth Massey

Tempoal, Mexico—Behind her welder's mask, Sophia Sanchez' face is wet with perspiration. The plaid shirt with lace around the collar is beginning to stick to her back. Her bright red nail polish is only just visible through the axle grease on her hands. Her long bead earrings reflect the sparks of the welding torch as she shapes a piece of metal tubing that will become part of a handpump for drinking water.

A huge skylight intensifies the heat on the workshop floor, where 15 women wearing T-shirts or brightly coloured blouses and jeans, drill, hammer, and work with lathes. The sound of their labour drifts over fields where the red earth is still steaming from the morning's short-lived downpour.

The Tempoal Handpump Factory is on the outskirts of this sleepy little town on a lush and humid coastal plain a few dozen miles from the Gulf of Mexico in the eastern state of Veracruz. Barely visible on the horizon are the Sierra Madre Oriental mountains, their peaks hidden by clouds and their flanks covered with oak and pine forests. Halfway up the slopes are the tiny fields in which, from time immemorial, farmers have grown the trinity of corn, beans and squash.

The beauty of the region masks the fact that it is one of the poorest in Mexico, where people have always had to struggle to make a living from the land. Many of them are landless peasants who earn less than US$3 a day working on coffee or sugarcane plantations. Others live on *ejidos*, collective farms, where they often have access to only five hectares of land. Health, nutrition, education and employment levels are among the lowest in the country.

For women it is especially hard. They are trapped by long days of working the land, grinding corn for tortillas, fetching water and firewood, washing, sewing, and tending to children and sick people. But they have little choice, with no job training, paid employment or access to credit to start income generating activities.

These were the obstacles that the group of women at the Tempoal Handpump Factory overcame in making the transition from unpaid farm workers to workshop managers. It took them eight long and hard years before they succeeded.

Change began in 1985 when the United Nations Development Fund for Women (UNIFEM) approved a grant of $150,000 to fund a development programme for rural women in the Tempoal region. The grant was channelled through a local women's organization, the Asociacíon de Mujeres Campesinas de la Huasteca, which has a membership of over 200 women in 11 groups.

Rural women have learned how to be welders.

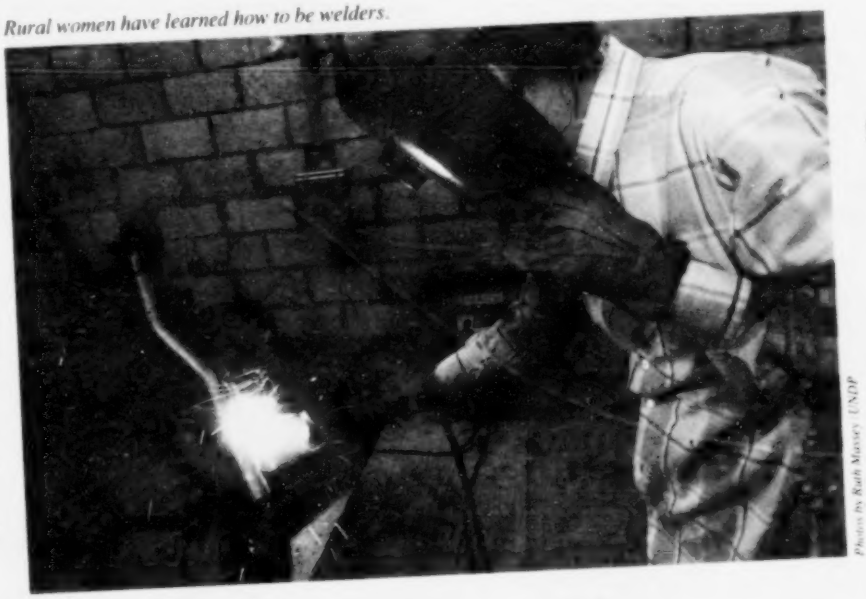

Photo by Ruth Massey, UNDP

READEX
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Petrol-driven maize mill ...

"First we went through training," says Inez Lara as she measures a length of tubing. "We learned simple production methods and how to organize our work. We bought petrol-driven maize mills to replace the old manual ones because grinding corn twice a day took five hours and we needed those hours to start projects from which we could finally earn some money." Like most of the women who work at the factory, she is a single mother.

While some groups started poultry farming and sheep raising, others grew sugar cane or citrus crops. Two groups built fish ponds while another installed a feed-mixing plant for chickens and pigs. Three small stores opened in 1986 selling consumer items at lower cost prices. By 1987, these enterprises were beginning to generate small profits.

The idea of manufacturing water pumps first came up when Jorge Zapp, director of Las Gaviotas, an appropriate technology centre in Colombia, came to Mexico and talked about a water pump that was being manufactured at his centre. Klaus Bethke, UNIFEM's Regional Representative, saw the pump when he went to Colombia in 1988, and brought one back to Tempoal. He suggested that the women manufacture the pump. "At first they were not enthusiastic," says Mr. Bethke. "But eventually they decided to try." An engineer from Las Gaviotas helped the women formulate the project for submission to UNIFEM, which approved a grant for $320,000 the following year.

That October, 10 women from Tempoal went to Las Gaviotas for two months training in operating lathes, welding equipment and various tools. "The men felt threatened by the possibility of being overtaken in knowledge and earnings by women and some reacted violently," says Mr. Bethke. "But the women's determination overcame resistance from husbands, brothers and boyfriends. Several of them left for Colombia with black eyes and bruises," he relates. But they all came back in December knowing how to produce a water pump and train the rest of the group.

With a $70,000 contribution from the Mexican government, the women

... frees many hours for women to work at the factory.

who stayed behind started construction of the workshop with help from local builders. Machinery was installed and three technicians from Las Gaviotas came to Tempoal for two months to make sure that the quality of the pump being produced was of the highest standard. By the middle of 1990, trial production had started.

"We produced 400 pumps in the first year," says factory manager Berta Rivera, "although we have the capacity to manufacture 5,000 a year." The pump costs $180 to produce and sells at $300 — a 40 per cent profit.

Despite its reasonable price, the pump is not selling well. Yet there are nearly 100,000 rural communities in Mexico without water systems for which the Tempoal pump is ideally suited. "Every day hundreds of thousands of rural women haul water from unhealthy sources. They could all benefit from this low-cost handpump," says Ms. Rivera. "The problem is that most people don't know it exists."

To get help with marketing, the group contacted Mexico's Ministry of Land Reform, one of whose priorities is women's issues. In June, the Ministry approved a grant of $20,000 to promote the pump and sent Guadalupe Martinez Ruiz, National Coordinator for Rural Women's Organizations, to Tempoal to discuss a marketing strategy.

The women were well prepared for the meeting, which took place at the workshop. First they demonstrated use of the machinery to manufacture the pump. Then they displayed sales charts alongside photographs of the group installing pumps in villages around Tempoal. A progress report was handed out. The marketing strategy was discussed and it was agreed to distribute a brochure on the pump to rural communities. The main selling points of the pump are its low cost, easy maintenance and the fact that it is manufactured locally.

After talking with the women and watching them work, Ms. Ruiz accompanied them to the nearby village of Las Mesillas, where she observed them install a pump. Their dexterity with tools and machinery earlier had been impressive. But what impressed Ms. Ruiz even more was the teamwork, speed and efficiency with which they installed the pump and had it working in just under an hour. A small boy was the first to try it, and as the trickle of clear water turned into a steady stream, the villagers cheered.

"We have a saying around here," said Ms. Rivera as Ms. Ruiz prepared to leave. "God gave us water, but He doesn't put it in pipelines." Ms. Ruiz smiled. "Then you must be His angels, completing the work," she replied. ■

Photos by Ruth Massey / UNDP

Berta Rivera (left) and Inez Lara install pump at Las Mesillas ...

... and the villagers have access to clean water.

Empowering Poor Communities in Tegucigalpa

By Robert Pini

Tegucigalpa, Honduras—As Lila Isabel Mejia describes how life has changed for her family since the neighbourhood got its own water supply, she proudly shows off the new shower and washing area under the shade trees on her patio. Her modest home is scrubbed and shining. "Now that we have water in our home, I have time to do other things," she says. "I have returned to school to finish my primary education, and afterward I want to become a seamstress."

"When there was no water, I used to spend one hour in the morning and time again some evenings, going back and forth to get water for drinking and cooking. I felt like I was always going out again to get more. Now we never lack clean water," she says. Mrs. Mejia and her family live in *21 de Febrero*—a 12-year-old community in Tegucigalpa, Honduras, named for the date when it was first occupied by squatters. Sprawling across hills and mountainsides, much of Tegucigalpa has been settled this way. Decades of war and political instability resulted in large population movements and urban migration throughout the Central American region. Over the past 10 years, Tegucigalpa has doubled in population to over 700,000 people, more than half of whom, like Mrs. Mejia and her family, live in one of the *barrios marginales* or marginal neighbourhoods.

Already there are more than 200 such neighbourhoods, ranging in population from a few hundred to tens of thousands. Tegucigalpa is projected to nearly double in size in the next 15 years, with most new arrivals likely to end up in unplanned and unhealthy *barrios*. As the capital of the second poorest country in the Western Hemisphere, Tegucigalpa is not prepared to handle this influx.

Most *barrios* lack basic public services, especially water and sanitation, and consist of very unhealthy living quarters. Bad water accounts for one-third of all deaths among children in Tegucigalpa. In the marginal neighbourhoods, the infant mortality rate has risen to as high as 100 per 1,000 live births. According to local health authorities, diarrhoea is the number one health problem. Yet, the story of Lila Isabel Mejia and her neighbours in *21 de Febrero* shows that a healthier life and basic services are not out of reach for squatter families.

The changes began in 1987, when the United Nations Children's Fund (UNICEF) joined forces with the Honduran National Water and Sanitation Agency (SANAA) to initiate the deliv-

ery of water to the *barrios* through a variety of innovative options. At the outset, there was no large-scale project or plan that envisioned a comprehensive, multiphased approach to service delivery. Unable to afford an expensive programme and lacking the institutional capacity to carry one out, SANAA began piecemeal, examining one *barrio* at a time for the potential to expand water supply. *21 de Febrero* received early attention. Since then SANAA's efforts have expanded throughout Tegucigalpa to 26 *barrios* whose residents have shown that they are highly motivated to develop their own water supplies.

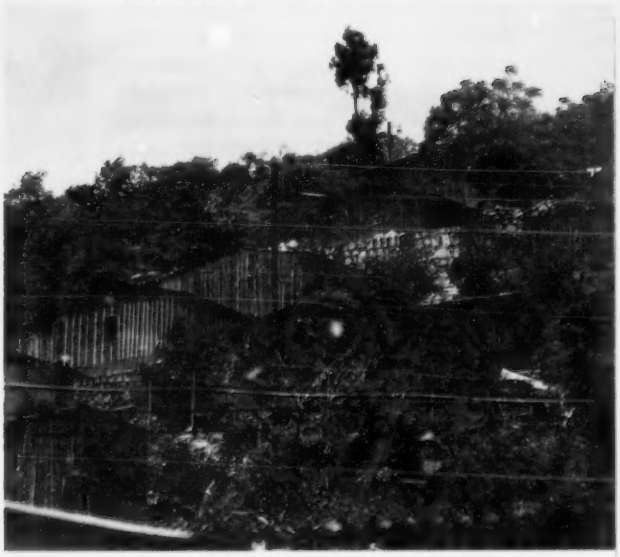
To deliver water to the poor, systems that function separately from the main water supply network are needed. SANAA's main system, which serves 68 per cent of the city, already experiences water shortages, especially during the seven-month-long dry season. Moreover, the rapidly growing squatter population lives mostly in communities above 1,150 metres in elevation, where it is not economical to extend the main system. So, SANAA created a special unit to deal with water supply in the *barrios* and designed three nonconventional supply options: drilling independent wells, trucking water to a community storage tank, and selling water from the existing network.

The *barrio* of Villa Nueva now receives water that is trucked in. Established about 12 years ago on the slippery hillsides of the southeastern outskirts of Tegucigalpa, and now home to 17,000 people, the sprawling community was served until recently by private water vendors who charged prices up to 34 times higher than the government rate. Estimates put the value of the private water market in Tegucigalpa at up to US$2 million per year, and a single family could pay more than 10 per cent of its income just for poor quality water.

Now three trucks making seven trips bring 52,000 litres of water each day to a roadside storage tank in the community. From there it is pumped to

Photos by Robert Pini / World Bank

Lila Isabel Mejia and her family enjoy better health and a cleaner environment from having safe water in their home.



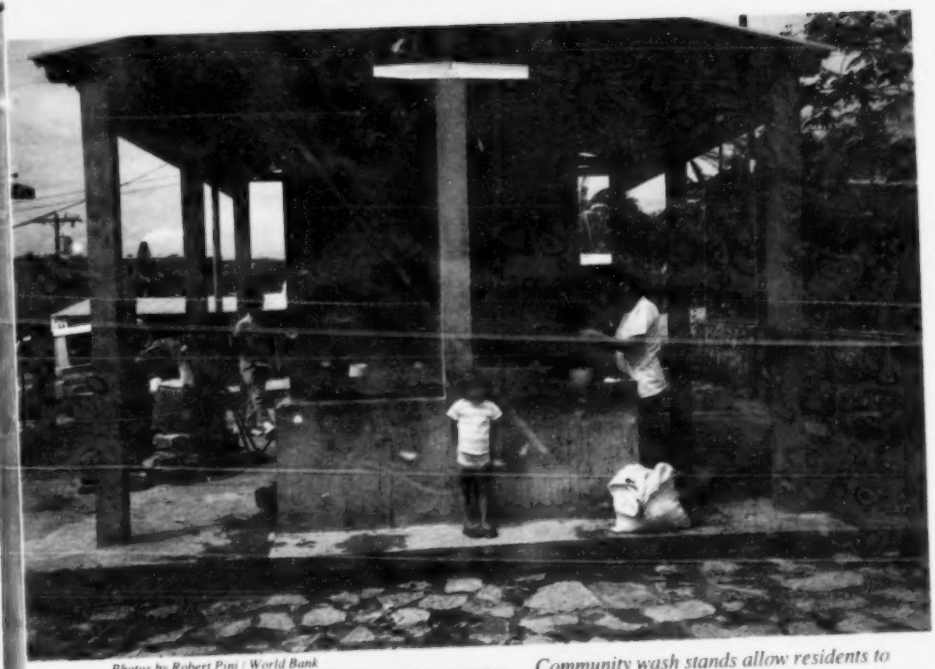
The rapidly growing squatter population lives in communitites above 1,150 metres in elevation.

smaller tanks and distributed through a network of public standpipes that serve groups of 20 families. Each standpipe is cared for by one individual who volunteers to hold the keys, and lock and unlock the post as needed. Almost two-thirds of the households in the community are already subscribers, with more expected to join once the system is completed.

In 11 other *barrios*, the well-drilling option was selected. Following the standard SANAA-UNICEF approach in the *barrios*, SANAA personnel assess the availability of water in each area, possible resources for improving supply, and community needs and interests. UNICEF renders technical assistance and supplies pipes and other equipment while the residents provide labour and all local materials, such as sand, gravel, bricks, and some fittings. Generally, the wells are drilled and equipped with submersible diesel pumps that raise the water up to large tanks on the hilltops above each community. SANAA engineers prefer these independent wells because they do not burden the already overstretched main water supply system, yet can be easily integrated with it in the future.

Due to the availability of groundwater in *21 de Febrero*, three wells were drilled and house connections installed. Nearly 90 per cent of the homes in the community receive water from the system, which has paid for itself. Subscribers pay $2.20 monthly to the local bank that handles the water committee account. Ovideo Rodriguez, a plumber employed by the water committee, distributes the bills each month. "Customers are cut off

A new government-funded sewerage system in a poor neighbourhood.



Photos by Robert Pini / World Bank

Community wash stands allow residents to bathe and wash laundry.

Posters inside latrines promote better hygiene practices.

from the system after two months of nonpayment, but there are very few who don't pay regularly," he says.

Under the conditions set out by SANAA-UNICEF, the monthly water tariff in the *barrios* is adjusted to recover capital costs as well as expenses for operation and maintenance, including salaries for tap attendants, administration, electricity to run the pumps, and repairs. As the community pays back the initial investment, the money goes into a revolving fund that can be used by other *barrios* for water supply. Part of the water tariff is also deposited in a fund used for other community development projects, such as sewerage or roadwork. The community of *21 de Febrero* intends to use nearly $43,000 it has banked to build its first drainage system.

Underpinning the success of the SANAA-UNICEF approach is strong community involvement, which springs partially from pre-existing local organizations. Despite their poverty and varied backgrounds, *barrio* residents have common goals and have organized themselves to plan their communities, secure services and ensure their rights are recognized. The resulting system of local representation provides a strong foundation for building local water committees. In turn, these committees, their capacities enhanced by technical and administrative assistance from SANAA, are effective in coordinating local effort and administering a system once it has been completed.

After nearly five years of expanding efforts, this coalition of agencies and communities has succeeded in bringing water to nearly 50,000 beneficiaries. Together SANAA and UNICEF continue to tap unconventional sources and cement new alliances in bringing water to the *barrios* of Tegucigalpa. Recently, they turned to the city's Chamber of Commerce to attract businesses interested in the sales that construction of new water systems could generate. ■

Water Changes Lives in the Bolivian Altiplano

La Palca, Bolivia — Water is precious on the arid Bolivian Altiplano, and settlements are always located where there is a steady source of supply. But for many years, the people of the tiny village of La Palca have been unable to drink from the nearby Mala River. Instead, they have watched it flow downstream, an orange ribbon contaminated by lead, arsenic, and mercury wastes from mining.

Hundreds of remote villages high in the Bolivian Andes share the problem of unsafe water. The little available surface water is often polluted, from unregulated mining or harmful microbes and bacteria. Inadequate sanitation reinforces the cycle of contamination that contributes to high child mortality. Nearly half of all children born in this perilous environment die before they are five years old, many from water-borne diseases, including diarrhoea. The average life span is only 34 years.

Fortunately for the 15 families in La Palca, life is changing. Amongst the old stone buildings and adobe houses are newly constructed latrines. A new well-head and handpump stand near the school grounds. For the past several months, the community has been working to construct these facilities with the help of a project known in the local Quechua dialect as *Yacupaj*, meaning water.

The *Yacupaj* project is assisting remote rural communities of 50 to 250 people in Bolivia's Potosi Department that are willing to contribute to and maintain improved water and sanitation systems. When the US$4 million project is completed in 1994, more than 75,000 people in small villages scattered across three rugged provinces in the southwest of Bolivia will have benefited.

However, Bolivian project director Rafael Vera does not like to concentrate on the numbers. "We want to reach as many people as we can," he says, "but this project emphasizes sustainability first. The community must see its own needs being met by the facilities members build with our help." Mr. Vera explains that changing community behaviour is most important. This

By Robert Pini

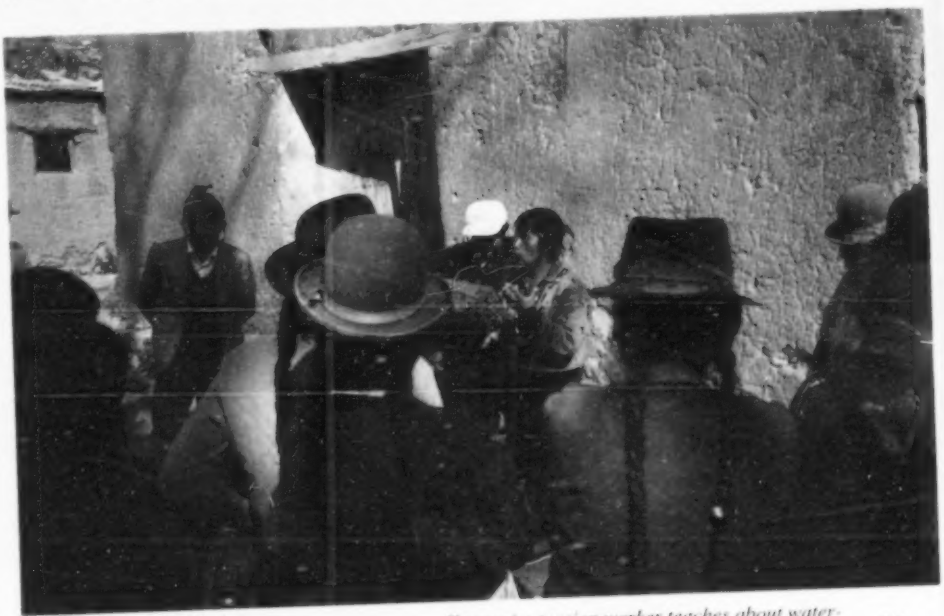
means educating individuals and families about good hygiene practices concerning water and sanitation.

Extension workers attached to provincial *Yacupaj* teams help to create demand for improved water and sanitation in small rural communities, assisted by local volunteers. Teachers, rural health workers, traditional leaders, government representatives, and auxiliary nurses assist too, visiting settlements to discuss health and hygiene objectives.

Funded by the Dutch government and implemented by the UNDP-World Bank Water and Sanitation Program, the *Yacupaj* project is also cooperating with the various government institutions and non-governmental organizations that deliver services at the provincial level. For example, the Tomas Katari Polytechnic Institute, which operates a large vocational school in the Chayanta province has become a partner in the technical and social aspects of project implementation. Provincial teams assist by documenting results and collecting unit cost information needed to review the replicability of different approaches. Participating institutions gain valuable experience, learning which factors are crucial to successful service delivery, and developing approaches that they can implement widely.

Making initial contact with local inhabitants takes time. During the rainy season, rural roads become impassable and main arteries are often cut by swollen rivers for days at a time. Extension work comes to a halt for many seasonal activities, such as harvests, long-distance trade, and fiestas.

When extension workers first came to La Palca to promote handpumps and latrines, community members were sceptical. "Villagers are often reluctant to work with us," says Virginia Chumacero, who supervises extension efforts in villages throughout Chayanta. "They are very busy with their daily activities, and it takes us two to four weeks just to establish a relationship with the community." Promoters begin by generating demand for better facilities, engrossing villagers in overall goals and improvements and assessing local needs. Then social and technical workers educate and assist community members in selecting,



Photos by Robert Pini/World Bank

Yacupaj extension worker teaches about waterborne diseases.

Vent-pipes emerge from the roofs of new latrines in La Palca.

building, and maintaining the water and sanitation systems.

Once convinced of the benefits of improved services, La Palca residents decided to request assistance, elected a leader to represent them, and formed a water committee. The first step was to diagnose needs and determine the community's ability to pay. Then a construction supervisor and water resources assistant worked with the water committee to design feasible technical solutions. Under the project, a community normally decides which water system it prefers and each family chooses between a ventilated improved pit (VIP) and a pour flush latrine. So, La Palca villagers made their selection: a Yaku handpump for the well; a VIP latrine for each family.

The community provided the labour and materials to build the facilities and also paid for transportation. The project paid for 70 per cent of materials not available locally, as well as for the contractor, who was selected by the village water committee. Members chose an artisan from the community who received additional training to do the skilled work.

When construction was completed, the residents of La Palca had secured safe drinking water for less than $12 per family. Ongoing hygiene education, provided at the village centre in the shade of the old Spanish-style adobe church, ensures that community members will receive the greatest benefit from the new facilities.

Yacupaj social workers have discovered that their success in securing community involvement is partially due to the underlying cooperative social structure in Andean cultures. The *ayllu*, a network of inter-relationships and mutual obligations within a group, orients these cultures toward community self-help. A single *ayllu* can comprise thousands of people and encompass thousands of square kilometres, governing everything from farming and taxes to rituals and festivals.

Efforts to educate highland women and children, the primary users of water, have also been quite successful. One reason for this, according to Alan Carroll, who coordinates work in Bolivia for the UNDP-World Bank Water and Sanitation Program, is that women hold many positions, both at the project's headquarters and in the field. For example, women have devised most of the materials for community education, writing them not only to inform but also to entertain. The lively stories and identifiable characters help villagers learn about health and hygiene practices and different types of water and sanitation systems.

In the villages, women play a key role in the difficult job of persuading communities to improve hygiene. Extension officer Marta Diaz promotes the project to isolated communities in the small railroad stop of Chita, in Quijarro province, riding her motorcycle through the bitter-cold wind to visit enclaves of as few as seven families. "Women are very interested in making improvements, but involving them is hard because they spend long hours working," she says.

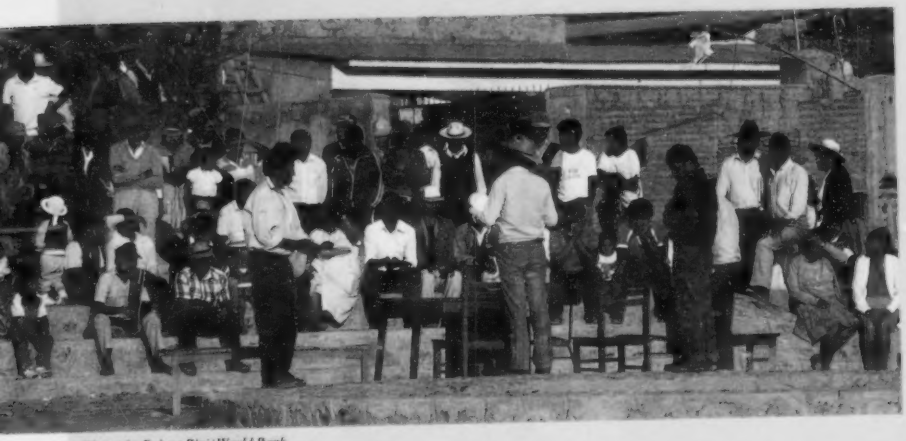
Taquiza Macha is another of the original communities to have benefited from *Yacupaj* activities. Like La Palca, it is a tiny village of farm families, consisting of 20 homes and a small school alongside a rutted mountain road. For years the community got its water from a small spring that, unprotected, was also a source of cholera and other waterborne diseases. With the help of the *Yacupaj* project , the families in Taquiza Macha capped the spring, channeled uncontaminated water to four public stand posts and built three latrines on the school grounds.

Top: Street sign advises villagers on the prevention of cholera.

Bottom: Yacupaj workers travel to remote villages through tough terrain.

It is early dawn. The village is nearly empty. Almost everyone is away, trading or herding. An old couple cooks breakfast over a tiny fire, peering curiously at a group from project headquarters that has come to inspect the latrines. Wrinkled yet resilient, their faces bear witness to a difficult life. Nearby, two children trundle over the windswept barren land to draw water from one of the new stand posts. With safe water and sanitation close at hand, their lives promise to be a little easier. ■

City Dwellers Willing to Pay for Water and Sanitation



Photos by Robert Pini/World Bank

Above: Government engineers meet with community members on the new water system.

Below: Local residents customize their own new facilities.

Cochabamba, Bolivia—Cochabamba is a rapidly growing city where Indian farmers, fleeing drought in the valleys of the high Andes, come to make a home. Hundreds of families from the Altiplano province of Oruro have migrated to the windswept neighbourhood of Villa Sebastian Pagador in hopes of finding jobs. Most of the new arrivals do not find basic water and sanitation services.

Until recently, families in Villa Sebastian Pagador purchased poor quality water at high rates from private vendors and stored it in unsanitary oil drums. Household sanitation was largely nonexistent and, as the community grew, problems from airborne diseases multiplied. They were especially bad during the dry season when the wind raised a germ-laden dust that blanketed everything with a layer of grit.

But residents of Villa Sebastian Pagador have found a way to improve health and hygiene. They are proud of their latrines and metered yard taps — new facilities constructed through the efforts of a community-based organization financed by US$200,000 from the International Development Association of the World Bank, and assistance from the Bolivian Environmental Sanitation Authority. The community formed its own association to promote and supervise the installation of water and sanitation services.

Contrary to expectations, preliminary studies by the UNDP-World Bank Water and Sanitation Program discovered that people were willing to pay for the more expensive water yard taps, rather than less costly stand posts. They also found that they would be willing to participate actively in a water committee.

Engineers working in Villa Sebastian Pagador also had to adjust to community demands. "We are used to making decisions and working quickly based on technical experience," says project engineer Gustavo Clavijo. "Now we must explain everything in detail, which makes work go more slowly. Sometimes the community still doesn't make the best technical decision. We must continue to talk until we reach an agreement."

Nearly 4,000 people in this peri-urban settlement have benefited from the improvements. Their enthusiasm for the new services can be seen by the number of latrines that have been completed and the number of modifications made to yard taps, including addition of plumbing and tanks for showers and wash basins. And despite having to bear the cost of pumping water from a well located several kilometres away, residents are still paying about 86 per cent less for water than they did when they bought it from vendors.—**R.P.**

Yemeni Farmers Learn to Conserve Precious Water

By I. Rajeswary

Sana'a, Republic of Yemen— Fruit farmer Muhammad Hamid Abdulla catches an afternoon snooze under a canopy of grape vines, a cool respite from the scorching summer heat. His farm, nestled in the shadow of Yemen's rugged mountains in the Bani Husheysh area, is an hour's drive north-east of the capital city of Sana'a. Mr. Abdulla, 45, is pleased. In two weeks, his luscious red and green grapes will be ready for plucking.

Six months ago, a nap at this time of day would have been a luxury as Mr. Abdulla would still be watering the vines on his eight-hectare farm. Today, he simply switches on an engine that activates a sprinkler irrigation system discharging water from spray nozzles mounted on pressurized pipes running the length of the furrows. "Now I realize how much water I had been wasting in the past," says Mr. Abdulla.

The system showers water around the roots of the vine thus conserving water, a precious scarcity in Yemen. The conventional gravity-flow system that Mr. Abdulla previously used to irrigate his farm involves pumping water from a well and channelling it through unlined, open ditches to the field. This resulted in tremendous waste because farmers often tend to over-irrigate their crops and a lot of water runs off the field.

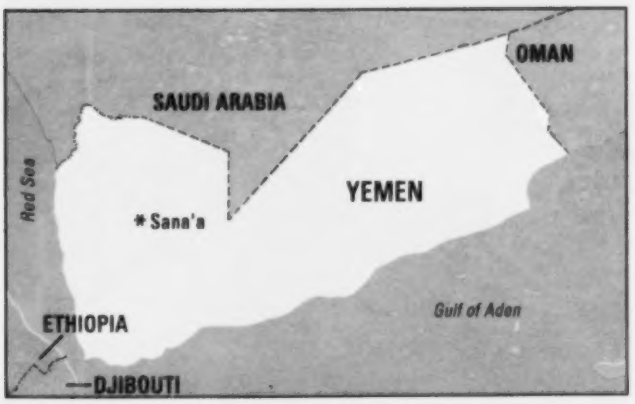
On another farm in the same area, Masuada Muhammad Hamran, 60, is experimenting with drip irrigation, a system that discharges water through a network of perforated piping that releases water close to the plants' roots. This method also minimizes evaporation and seepage losses.

With help from her two daughters, Ms. Hamran cultivates onions, cucumbers, tomatoes, sorghum and wheat as well as grapes and peaches on her six-hectare farm. "Now, there is better control of water," she says. "I also have a little bit more time to ferry my husband to the hospital to get his medication." Her husband, who used to attend to the heavy chores on the field, has been unable to help her since he became ill 10 years ago.

The Republic of Yemen, a country of over 12 million people in the south-east of the Arabian Peninsula, emerged in 1990 following the merger of the former Yemen Arab Republic and People's Democratic Republic of Yemen. It is blessed with a diversified climate suitable for growing a wide variety of fruits, vegetables and agricultural crops. Agriculture forms the backbone of the Yemeni economy, generating 25 per cent of the Gross National Product and employing 62 per cent of the labour force, more than two-thirds of whom are women.

However, the potential growth of this sector is constrained by limited water resources and wasteful and inefficient irrigation. There are 3.6 million hectares of agricultural land in Yemen. Less than 40 per cent of this arable land is cultivated, 20 per cent under irrigation and 54 per cent through rainfed agriculture. Twenty-six per cent is left fallow because of a lack of rainfall, which varies from 150 millimetres to 45 millimetres a year.

Water for agriculture in Yemen is

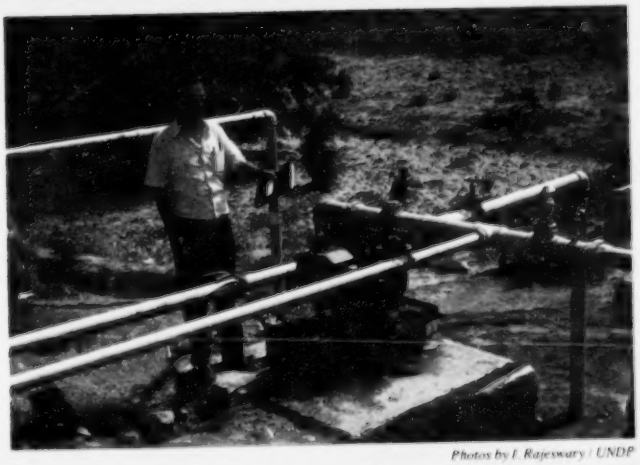


Mr. Mustafa Saud inspects an irrigation spray nozzle.

drawn from rains, floods, springs and groundwater. In every major aquifer in the north, the groundwater level is dropping steadily, at a rate ranging from 0.5 to seven metres annually. Consumption already outpaces available supply. It is estimated that by the year 2010, urban and industrial water needs alone will consume half the amount of underground water available annually.

A government-commissioned report by the United Nations Development Programme (UNDP) on Yemen's water sector warns that "unless groundwater abstractions are brought under control, municipal supplies will be threatened, many farms and villages will be abandoned, local economies will be disrupted, and the national economy weakened."

The government strategy is to optimize the use of limited water resources in irrigation and protect water aquifers while maximizing agricultural production and productivity. To manage water at farm level, UNDP and the Dutch government collaborated with the Yemeni government to introduce appropriate irrigation systems and technologies in the Sana'a governorate three years ago. Local engineers, technicians and farmers were trained in the



A generator pumps water from a well to the farm.

Photos by I. Rajeswary / UNDP

Ms. Masuada Hamran with her "best grape farmer" award.

Ms. Masuada Hamran taps water from this well.

management and maintenance of equipment to ensure sustainability of the systems. Twenty privately-owned and four state-owned farms have benefited from this US$3.3 million pilot project executed by the Food and Agriculture Organization (FAO) of the UN.

In Yemen, there has always been a critical relationship between water, the quality of life and development, and even today, only 30 per cent of Yemenis have access to safe water. This link became more crucial in the last decade, largely due to rapid population growth and urbanization. As the agricultural sector was called upon to feed more mouths, the demand for water increased.

To obtain sufficient water for irrigation, farmers were forced to tap into underground water-tables. "Even those who were practising rainfed agriculture started drilling wells to extract water," says Mohamed Burale Farah, an irrigation engineer from Somalia and chief technical advisor for the project. "And they tapped these water tables at a much faster rate than nature can replenish them."

Moreover, farmers felt it was their right to drill to their heart's desire after having laid down nearly $21,000—a huge sum in poor Yemeni communities—for drilling, well construction, installation of a hydraulic pump and fixtures such as casings and pipes. "In a culture where water is considered a gift from God," explains Mr. Farah, "a farmer feels he can pump as much as he wants, especially after the amount of money he has spent." In the northern governorates alone, nearly 2,600 million cubic metres of water are extracted annually, 90 per cent of which goes towards irrigation.

Today, some 45,000 wells are estimated to be operational in Yemen and the number is increasing every year. Mr. Farah says the government fears that over-pumping and dropping ground water tables could result in salinization through sea water intrusion. This would affect the environment and jeopardize sustainable agricultural development. "That is why educating farmers is very important," he explains.

Mr. Farah is assisted by Mustafa Saud, a Yemeni soil and irrigation engineer, who visits the farmers in his four-wheel drive to monitor their progress. "We consult the farmer to make him or her understand the advantage of an improved system of irrigation before we install it on the farm," Mr. Saud explains. "If they do not realize the consequences of their actions, they will not make an effort to manage water resources properly or responsibly."

Winning farmers over is not easy. Mr. Saud says initially they are not receptive to new technologies but they usually agree to a trial run. "When they see how the modern technique sustains the irrigated area, they are converted." Often, farms belonging to Mr. Abdulla and Ms. Hamran are used as demonstration sites.

Mr. Farah says that in the last three years, improved irrigation technologies and practices on Yemeni farms have not only resulted in major water savings but enabled farmers to reduce the overall abstraction of groundwater. They were also able to prevent soil erosion and waterlogging in the fields.

In addition to instructing farmers, the project enabled 17 Yemeni engineers to travel to Cyprus, Egypt, Jordan, Tunisia and the United States to be trained in irrigation system design, technologies, costing and installation. These local engineers now take the lead in the design, installation, operation and maintenance of all modern irrigation systems in the Ministry of Agriculture and Water Resources.

The government is pleased with the impact of the project and would like to extend it beyond the selected private and state farms involved in the pilot demonstrations. Mr. Farah says many farmers wish to adopt the modern techniques but find the costs for drilling and purchase of a generator prohibitive. Other snags include lengthy bureaucratic procedures in clearing equipment entering the country.

But the government is determined to iron out these problems. UNDP is funding a project to strengthen the technical secretariat of the High Water Council through the establishment of a data bank, water basin assessment, draft legislation and water management advice. It is executed by the UN Department of Technical Cooperation for Development (now known as the Department of Economic and Social Development). A nationwide on-farm irrigation water management programme is under consideration to motivate farmers to undertake measures that can improve traditional surface irrigation systems. Farmers like Mr. Abdulla and Ms. Hamran bear testimony to the benefits modern irrigation systems promise. ■

Open drain, now dry, no longer threatens disease for Jabalia's children.

Cleaning Up Jabalia's Sewers

By Mary Lynn Hanley

Jabalia, Occupied Gaza Strip— Apart from the mesh wire fences that mark its boundaries, Jabalia refugee camp seems like a bustling Arab town. Drab but solid houses fashioned from grey stone blocks stand clustered together, sprouting TV antennae from their corrugated tin roofs. Merchants offer an array of foodstuffs, clothing, household items and children's toys from well-established shops. Donkey carts ferry colourful bolts of printed fabric and cages with live poultry through the dusty unpaved streets. On this sunny July day, with school closed for the summer, children scamper everywhere.

Only a year ago, frolicking youngsters were in grave danger of contracting one of the parasitic diseases that affected 70 per cent of Jabalia's children. Now, a US$5.2 million closed sewer system has made the camp a much healthier place in which to live. Construction was managed by the United Nations Development Programme (UNDP) under its Programme of Assistance to the Palestinian People (PAPP). For the past 12 years the PAPP has been helping Palestinians in the Israeli-occupied territories of the West Bank and Gaza Strip improve health care, education and economic prospects.

With 62,000 inhabitants living in an area of 1.8 square kilometres, Jabalia is the largest refugee camp in the territories. It has been operated by the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNWRA) for over 40 years, during which haphazard and random settlements have become permanent homes for three generations of Palestinian refugees. Half the population is under 20 years of age.

Before the closed sewers were installed, uncovered ditches from each

Photos by Mary Lynn Hanley / UNDP

Atta Shaqura and his family now live in a much healthier environment.

household carried raw sewage to a huge open pit at the lower end of the camp. This squalid network blanketed the whole area with a foul stench, posing a serious threat to health, and even life. More than once, children fell into the pit and drowned in its noxious waters.

Atta Shaqura, an assistant pharmacist who moved into Jabalia camp in 1955 when he was 15 years old, and subsequently married and brought up his 12 children there, remembers what it was like. "There were open drains full of sewage water that over-flowed onto the streets," he says. "My children stayed clean playing in the house but became filthy as soon as they went outside."

Added to the polluted environment was the economic burden. "We had to pay to have the sewage holes leading from the house to the ditches vacuumed," Mr. Shaqura recalls. "There was also the cost of draining the barrels into which waste from latrineswas dumped. Sometimes the vacuum tankers contracted to do this overflowed and their contents mixed with the waste water in the streets. It was terrible."

Problems were especially acute during the rainy winter season when houses became flooded due to lack of drainage. "Even last winter, 20 homes had to be evacuated," Mr. Shaqura says.

The new sewer system consists of pipes, laid under the ground, and attached to houses by connections covered with manhole covers. Through gravity, sewage flows to a giant filter installed next to the area which once held the festering pond. As it goes through a mechanical screen the large particles of garbage are removed from the sewer water before it is pumped to a treatment plant outside the camp, five kilometres away.

Construction of the system was handled by Palestinian contractors, who employed labourers from the local community. Residents of the camp

e territories, these services get high iority. Since the programme's incep- on, water supply schemes under- ken in 14 West Bank villages have enefited over 80,000 Palestinians rough improvement of wells, con- ruction of pumping stations, building f water reservoirs and installation of istribution networks and house con- ections. Another sewer project is nder way in the Balata refugee camp, ome to 14,000 people outside the Vest Bank town of Nablus. Here, a adly deteriorated system is being eplaced through a $550,000 project, or which Japan is providing $400,000.

For the Jabalia system, UNDP's contribution of $1.2 million was matched by $1 million each from Japan, the United States and the AGFUND. In addition to the greater Jabalia area, it covers the nearby

Photos by Mary Lynn Hanley / UNDP

Main road, Jabalia refugee camp.

communities of Beit Lahia and Beit Hanun—a total of 3,241 hectares with a population approaching 100,000 that is expected to reach 160,000 by the year 2000. The present volume of sewage—four million cubic metres per year—is likely to double by that time.

A complementary $523,000 UNDP-supported project is developing local capacity to manage, maintain and administer the Jabalia system, as well as to treat and recycle effluent from nearby Gaza city. Equipment, tools and training are provided to municipality and local council staff, who will take over management of the system. Intensive on-the-job training is equipping a core of Palestinian engineers and technicians to oversee, maintain and operate the installations.

UNDP research and liaison officer, Omar Daoudi, explains that a separate $1.9 million UNDP-supported project will focus on recycling the water from the Jabalia system, as well as effluent from Gaza city, for irrigation of citrus, Gaza's largest crop. Before being pumped to the orchards the treated sewage will be analyzed in laboratories to ensure that it is safe for watering fruit trees.

"This is the first time that the Palestinians in the Gaza Strip will use treated sewage water for irrigation," says Mr. Daoudi. "We will go through a long educational exercise with the farmers."

Mr. Daoudi suspects that because water in Gaza is strictly controlled by the Israeli authorities, farmers will fear a cut in their rations if they start using water from a previously untapped source. "We are trying to use the treated sewage water for additional land," he says. "We are hoping to expand the cultivated area."

In the few short months that the Jabalia sewer system has been in operation, Mr. Shaqura has noticed that his children have contracted fewer infections, that the air smells better, and that the mosquito population is down. Also appreciative of the change is Abu Fayez Okasha, the "Mukhtar," or leading dignitary of Jabalia, who has observed a vast improvement in people's health. And Mr. Okasha sees another positive effect. "If you go through the camp you can see new construction," he says. "Installation of the sewer has encouraged people to invest and improve their houses."

Still, according to the Mukhtar, needs are very far from being met. As a next step, he would like to see the project extended to cover some 10,000 people who have moved from the camp to a surrounding area which does not yet have sewerage. ■

Karachi's Poor Neighbourhoods Achieve Low-Cost Sanitation

An alleyway in Orangi before the advent of sanitation.

By Arif Hasan

Karachi, Pakistan—Nearly one million poor and working class people reside in Orangi Township, a slum built on state-owned lands in Karachi. In recent decades, Orangi has grown to more than 94,000 houses standing along 6,200 narrow lanes and alleyways, making it one of the largest of Karachi's 500 squatter colonies.

Until the early 1980s, this burgeoning township had no organized sanitation system. Most people in Orangi used bucket latrines that were emptied every four or five days, often on unpaved lanes. More affluent households had crude soakpits which filled after a few years and had to be cleaned out. Where people laid their own sewerage pipes, defects caused leaks and many parallel lines ran along a single lane.

Today, however, much of Orangi has been transformed: almost 75 per cent of the houses have sanitary latrines with an underground sanitation system. Thanks to an approach to sanitation combining low-cost technology with maximum community participation, the improvements cost less than US$50 per household.

The catalytic force behind this transformation is the non-governmental Orangi Pilot Project (OPP), started in 1980 by Pakistani community development specialist, Dr. Akhtar Hameed Khan, with support from the Bank of Credit and Commerce International. Using unconventional approaches to financing, design, construction and management of sewerage systems, the OPP overcame several obstacles to servicing poor urban communities with adequate sanitation.

Most municipal authorities cannot afford to construct sewerage systems for squatter settlements. External loans obtained for this purpose have to be paid back and can usually address only a small part of an immense problem. Four million people live in squatter colonies in Karachi alone. Moreover, the investment cost of conventional urban sewerage services is typically five times the cost of labour and materials. This increases by 30 to 40 per cent when foreign loans are involved, and by over 200 per cent when international tenders are required under loan agreements. Squatters simply cannot afford to pay the enormous costs that result.

OPP's low-cost sanitation programme aims to discover alternative sources of finance and a new method of implementation that would not cost more than the materials and local labour. To reach these objectives, it was necessary to scrutinize previous solutions to the people's sanitation prob-

Arif Hasan is a Pakistani architect who specializes in human settlement issues.

Photos by Arif Hasan

Orangi residents laying sewer pipes.

lems and to understand their aspirations.

Most people in Orangi wanted an underground sewerage system. The project organizers realized that with the right technical support and tools, and proper training, community members could finance and construct such a system for themselves.

Three concepts were central to achieving that reality: community participation, modification of standard engineering technology and implementation procedures, and redefinition of relations between the community and local government.

The first step was to form community organizations with a manager for each lane, which in Orangi consists of 20 to 30 houses. Social organizers met with residents lane-by-lane. Using slides, models and pamphlets, they explained the objectives and the economic and health benefits of the project. People understood that if they agreed to participate, the project would assist them in meeting costs.

The project's technical staff then surveyed the lane, established benchmarks, prepared plans and estimates and handed them over to the manager, who collected the money the people had agreed to contribute and met with them to sort out any sociological problems connected with the work.

Residents were taught to construct their sewer lines using a variety of methods. As there was no central supervisory and controlling agency, people initially worked on their own. This resulted in some sub-standard construction and, in 1982, a thorough reevaluation of the programme's concept, design and implementation. The substandard work was analyzed and engineering designs simplified. In hundreds of training sessions people learned about mixing and curing concrete and making inverts to manholes. Masons were trained in sanitation technology. The standard of work improved dramatically.

Initially only those lanes that were accessible to a natural creek or *nullah* requested assistance. The project therefore involved universities and colleges in the activities, arranging for architecture and engineering students to carry out a physical survey of Orangi and explain the function of secondary or collector drains to community members. Survey results were communicated to the local councillors, who felt pressured to take an interest in the matter. Finally, many neighbourhood lane organizations came together and requested technical assistance for the construction of secondary drains.

After 10 years of cooperation, there is no longer a need to motivate the people in Orangi. Lanes organize themselves and contact the OPP for technical assistance. OPP identifies locations where secondary drains should be constructed and helps with the construction of primary drains. It also designs and supervises works financed by the Karachi Municipal Corporation, for which it has become a research and extension agency.

Today, nearly three-quarters of the houses have sanitary latrines and three-quarters of the lanes have an underground sewerage line. Nearly 350 secondary drains collect and carry effluent to the open *nullahs*. The people of Orangi have invested over $2 million in this effort and they maintain the system which they financed and built. OPP's administrative, research and extension costs have amounted to $153,000—a ratio of over 13:1 of people's costs to OPP's expenditures.

Surveys carried out by the Aga Khan Medical University confirm that health conditions in Orangi have improved and real estate prices have increased. In addition, OPP now has equipment, technical manpower and social organizers who understand not only sanitation problems of low-income settlements, but also the processes required to involve and train communities in solving them.

OPP's low-cost sanitation programme is being replicated by a number of NGOs in other squatter settlements in Karachi and Lahore. It is also being replicated by UNICEF in three cities in Sindh and by the World Bank-sponsored *Shelter for Low Income Communities Project* in Hyderabad, India. In all these cases, OPP is acting as the consultant and is responsible for training social organizers and government officials in its recently-established Research and Training Institute in Orangi. The Orangi squatter colony serves as a demonstration area.

But some problems remain. The *nullahs* which carry the sewage to the sea are silting up and are prone to flooding during heavy rains. The sewage that flows into the sea from Orangi and the rest of Karachi is untreated. OPP has designed trunk sewers and is lobbying the Karachi Municipal Corporation to implement them since these and treatment plants are beyond the capacities of Orangi residents.

OPP has demonstrated how to break down psychological, social, economic and technical barriers that thwart many communities in their development efforts. It has motivated communities to organize themselves to obtain and apply low-cost technologies for a healthier environment. The ongoing efforts are proof that better sanitation is only the beginning of community development. On the basis of the experience gained in the sanitation programme, OPP is now helping communities carry out a housing programme, women's health and family planning activities, and a supervised credit programme for small family enterprises. ■

Conserving Water in Cities

Washington, DC—Reduce, reuse, and recycle to reap economic and environmental benefits are the basic principles of the new Capacity Building Project for Urban Water Demand and Assets Management. Supported by the United Nations Development Programme and executed by the World Bank, it responds to the increasingly serious water supply and demand management problems facing urban areas in developing countries.

Rapid urbanization and population growth have placed excessive demands on scarce water resources in towns and cities. The project is promoting judicious management of water assets and demand to alleviate critical water shortages, high rates of unaccounted for water, weak institutional capacity, and worsening environmental conditions.

Participating developing countries will be able to delay expensive new supply projects by three to five years, achieving savings from improved operations and maintenance costs, as well as from foregone interest payments and depreciation. Water utilities will benefit from improved cost recovery, reduced operation and maintenance costs, and delayed investment in additional water resources development. Consumers, especially industrial users, will reduce their water bills and realize significant savings. Moreover, water that is conserved becomes available to the previously unserved urban poor.

Water wastage in urban areas of developing countries is a common and serious problem, with most water lost through leakages, poor metering, and illegal connections. The cost of unaccounted for water—to the utility, consumers, and the environment—is high. For utilities, it means unrecoverable costs. Substantial revenue losses weaken an institution's capacity to resolve problems and reduce performance of its systems. Existing water resources, which are often scarce and overused, are depleted or deteriorate in quality. This leaves the water utility no recourse but to develop additional resources, at great expense.

The project is targeting these problems through a step-by-step process integrating appropriate demand management strategies with water conservation measures. Precise metering and leakage detection programmes will identify and immediately address problems, and continuously maintain the supply system. Inefficient residential fixtures will be replaced by water conserving toilets, taps, and showerheads. Wasteful industrial processes will be modernized to recycle and reuse water. Demand will be managed through precise metering and tariff structures that reflect the costs of water. Educational campaigns will be mounted and regulations will require users to comply with restrictions.

Demonstration sites in Chile, China, and the Republic of Korea have been selected to incorporate water conservation components and demand management measures into upcoming World Bank projects. These sites will show that savings—in value and in volume—are significant, and can be replicated on a larger scale.

Local authorities and staff are being encouraged to administer and manage the demonstration sites and on-the-job training will prepare local staff for future large-scale programmes.

An international seminar in Dalian, China in April 1993 will provide a forum to discuss water conservation activities and expose national and provincial staff to related conservation and demand management issues. China's Water Minister and other provincial and urban water officials are expected to participate. Project demonstration sites will be visited. A Compendium of Urban Water Demand and Assets Management is being compiled for distribution at the seminar. ■

For additional information or to make research contributions to the Compendium, please contact Saul Arlosoroff, Project Manager, or Jodi Felberg, Research Analyst, at The World Bank, Water and Sanitation Division, Room S11-065, 1818 H Street, NW, Washington, DC 20433. Fax: 202-477-0164.

FROM THE UNDP-WORLD BANK WATER AND SANITATION PROGRAM

REUSE OF HUMAN WASTES IN AQUACULTURE: A TECHNICAL REVIEW
By Peter Edwards.
Water and Sanitation Report, No. 2
April 1992, 350 pages
Available free of charge from:
UNDP-World Bank Water and
Sanitation Program
The World Bank
1818 H Street, NW
Washington, DC 20433, USA

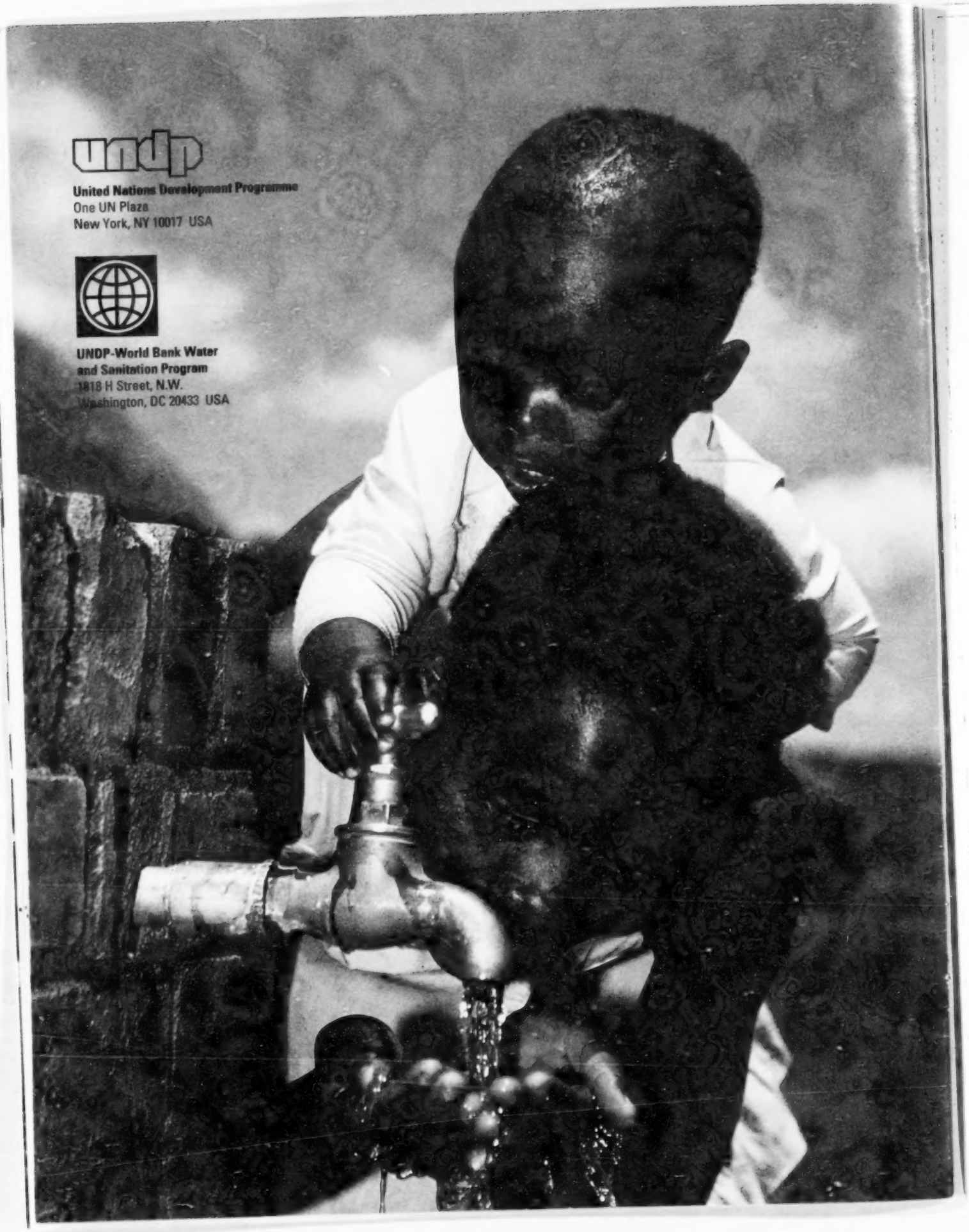
Many developing countries face both nutritional and water quality problems. Reusing human wastes to grow fish may be one possible solution. The reuse of excreta in aquaculture can spawn significant benefits and achieve a variety of goals. This report provides a detailed account of past and existing freshwater excreta-reuse systems, discusses sanitation options that can be linked to aquaculture, and considers design criteria for such reuse systems.

IMPROVING SERVICES FOR THE POOR: A PROGRAM STRATEGY FOR THE 1990s
July 1992, 16 pages
Available free of charge from:
UNDP-World Bank Water and
Sanitation Program
The World Bank
1818 H Street, NW
Washington, DC 20433, USA

This brief document outlines the strategy being pursued by the joint program during the next five years. It highlights the primary program goals — sustainable investments, capacity building and knowledge dissemination—and explains how the strategy is being implemented through "action-oriented learning," country-level operations and working partnerships.

HOUSEHOLD DEMAND FOR IMPROVED SANITATION SERVICES: A CASE STUDY OF KUMASI, GHANA
By Dale Whittington et al.
Water and Sanitation Report No. 3
May 1992, 118 pages
Available free of charge from:
UNDP-World Bank Water and
Sanitation Program
The World Bank
1818 H Street, NW
Washington, DC 20433, USA

This report describes the results of a large contingent valuation survey conducted in Kumasi to estimate households' willingness to pay for two types of improved sanitation services, ventilated improved pit latrines (VIPs) and water closets connected to a sewer system. It concludes that conventional sewerage is not affordable to the vast majority without massive subsidies but that high levels of coverage could be attained using VIPs supported with modest subsidies.



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